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Valuing Health using EQ-5D: The impact of chronic diseases on the stock of health.

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Abstract

Chronic diseases strongly affect individuals' health status. In aggregate terms, this impact is reflected by the *stock of health*, which measures the amount of health of a population in a given period of time.

Objectives: To measure of the relative burden of chronic illness by assessing health-related quality of life (HRQoL) using the EQ-5D-5L instrument. To rank diseases according to their associations with the stock of health. To calculate the stock of health of the Spanish population and the amount of health loss attributable to each chronic disease from a social perspective.

Data and Methods: Data were gathered from the Spanish Health Survey (ENSE 2011-12, N = 20,587). Models: A population weighted least squares model was used.

Results: Chronic diseases represent 19.19% of the stock of health losses in Spain compared to a country free from those diseases. In Spain, the stock of health in 2011 was 31.86 million units on the VAS.

The diseases with the strongest impact in terms of loss of stock of health at the individual level were mental illness and embolism, stroke or cerebral hemorrhage. Collectively, the diseases with the largest impact included osteoarthritis, arthritis, or rheumatism, chronic back pain, and high blood pressure.

Keywords: Stock of health, Chronic diseases, Visual Analog Scale, EQ-5D, EQ-5D-5L

1. Introduction

A *stock variable* measures magnitude at an instant in time. *Health* is *"*the state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*"* (WHO, 1946). This definition emphasizes the multidimensional and subjective features of health. *Health* care outcomes should therefore be measured multidimensionality and include the subjective experience of the patient (Saarni *et al*., 2006). In this paper, we described the stock of health concept as defined by Grossman (Grossman, 1972). The stock of health is the amount of health of a population in a geographical area. The *stock of health* variable considered in our analyses is the amount of health of a population of a country. Like Grossman's model, this assessment assumes that individuals inherit an initial stock of health that depreciates over time at an increasing rate after some stage in the life cycle. Stock of health can be increased by health investments. In this paper, we quantify the stock of health of the population in a country as a macroeconomic variable akin to how the gross domestic product (GDP) or consumer price index measures wealth or price evolution for a specific population.

Health-related quality of life (HRQoL) combined with quantity of life provide a holistic snapshot of health. There are many HRQoL instruments, but there is still no gold standard in HRQoL measurement. The EQ-5D is one of the most used instruments worldwide. The EQ-5D is a multiattribute, generic, preference-based health status measure, applicable to general populations and patients with various diseases (Brooks, 1996). Despite its brevity, the EQ-5D has consistently shown excellent psychometric properties (Stucki et al., 1995; Fisk, Brown & Sketris, 2005; Lamers *et al.*, 2006; Van Stel & Buskens, 2006).

The impact of chronic diseases on individuals' health status has been extensively studied (Lam, 1995). Nevertheless, there is no consensus on defining and classifying chronic

diseases. These definitions exhibit heterogeneity in several characteristics, such as duration or latency, need for medical attention, effect on function, pathology, departure from well-being, contagiousness, associated risk factors, and responsiveness to treatment (Goodman e*t al*., 2013). Therefore, there are different classifications of chronic diseases, which make comparisons across diseases difficult (Nordenfelt *et al*., 2014; Stewart, Greenfield & Hays, 1989; De-Bock et al., 1995; Smeele, *et al.*, 1998; Krousel-Wood & Richard, 1994; Jaffe, Froom & Galambos, 1994; De Grauw *et al.*, 1999).

Some studies aggregate chronic diseases to present results regardless of the impact of different diseases on individuals' self-rated health or health status (Lam & Lauder, 2000; Lubetkin *et al.*, 2005; Wu *et al.*, 2015). For example, in 2012, the Centers for Medicare and Medicaid Services selected twenty-one condition indicators from the Chronic Condition Data Warehouse (CCW) (Centers for Medicare and Medicaid Services, 2012). These predefined conditions included a combination of common chronic conditions among older adults and were designed to allow for streamlined data extraction of disease cohorts from the CCW. However, when presenting the results of the study, 15 chronic diseases and multiple chronic conditions were presented in ranges of 0-1, 2-3, and 4-5 or more. Under this classification, a patient with asthma was considered equally important as a patient with cancer. In other studies, aggregation is done by incorporating a monetary value for the disease (Schneider, O'Donell & Dean, 2009; Ward & Schiller, 2013; Tinetti, Fried & Boyd, 2012). While this information is useful for financing the health care system, it is inaccurate for establishing health policies.

The impact of chronic diseases on health has been estimated in the literature using different methods. Two methods are particularly important: disability-adjusted life-years (DALYs) and HRQoL per patient. An estimation of losses using DALYs requires disability weights that quantify health losses for nonfatal consequences of diseases and

injuries (WHO, 2008; Salomon et al., 2012). When the impact of a wide range of chronic conditions are expressed in terms of HRQoL, researchers calculate the impact that different diseases have on different measures of HRQoL per patient (Moussavi et al., 2007; Saarni et al., 2006). In this study, we followed this second approach using a functional form that relates HRQoL measures to chronic diseases (Barton et al., 2008). Models similar to the one used in this article have been developed for the estimation of population norms with the goal of presenting variations in health indices because of changes in the values of the EQ-5D dimensions (Jansen et al., 2014; Greiner et al., 2003; Polsky et al., 2001). Other authors have used the same indices (e.g., SF-6D, VAS, EQ INDEX) and introduced dummy variables for clinical conditions as regressors (Barton et al., 2008).

Most studies take the perspective of the patient or of the health care system to calculate the impact of chronic diseases. This study conducts a broader calculation from a social perspective, presenting the result as a macro measure of the health of the population.

2. Objectives

The first objective of this study was to obtain a measure of the relative burden of chronic illness based on HRQoL using the EQ-5D-5L instrument.

The second objective was to rank diseases by their association with the stock of health.

The third objective was to calculate the stock of health in Spain and the impact each chronic disease has on it.

3. Data and Methods

3.1 Survey design

The Spanish Health National Survey (ENSE) is jointly conducted by the Ministry of Health, Social Services and Equality and the National Institute of Statistics (MSSSI / INE) and conducted among a representative sample (by gender, age and region) of the noninstitutionalized population of Spain. Therefore, the results of this study are extrapolated to the Spanish population. Interviewers administered the survey in interviewees' home using computers. The interview was conducted face to face among adults. A total of 26,502 interviews were conducted between July 2011 and June 2012. The working sample was restricted to adults aged 18 and over who responded to the ENSE (N = 20,587). All individuals assessed, by responding to a specific question, whether or not they were diagnosed with a chronic disease. There are no ethical issues to report; every respondent provided informed consent, and all data were anonymized.

3.2 HRQoL Variables

The EQ-5D is a self-administered questionnaire that consists of two parts: the descriptive system and the visual analog scale (VAS).

The EQ-5D-5L descriptive system, a new version of the EQ-5D (Herdman et al., 2011), is the first part of the questionnaire, in which the current health status of individuals is described using 5 dimensions (mobility, self-care, usual activities, pain / discomfort, and anxiety / depression). The severity of each of these dimensions is rated on a five-point scale: no problem (1), slight problems (2), moderate problems (3), severe problems (4), extreme problems or inability (5). For each dimension each respondent indicated the level that best reflected his or her status at the moment of the interview. The overall health

profile of every respondent was described by a five-digit number. Each digit took discrete values from 1 to 5, with 11111 considered the best possible health profile and 55555 the worst possible health profile. In total, 3125 possible health profiles can be found. Recently, the EuroQol group developed a study protocol to obtain measures of health states assessed by the EQ-5D-5L, which combines two measurement preferences techniques for health states, time trade off (TTO) and the discrete choice method (DC). This protocol was implemented in Spain among a representative sample (Ramos-Goñi et al., 2014). The EQ-5D-5L index measurements used in this paper were calculated using the results presented by Ramos-Goñi et al. (2017). The values of the EQ-5D-5L index were calculated to estimate quality-adjusted life years (QALYs) using [-1,1] range of values.

In the visual analog scale (VAS), the respondent evaluated his or her current health status in a millimeter scale of 20 cm with the endpoints labeled "the best health you can imagine" (100) and "the worst health you can imagine" (0).

In this study, both the EQ-5D-5L index and the VAS were used as HRQoL measures. The VAS was self-reported by respondents and provided data on individuals' subjective perceptions of all aspects of their health. The EQ-5D-5L index was elicited through preference measurement techniques and was restricted to the 5 dimensions of the EQ-5D.

3.3 Models specification.

We used a general linear model to estimate the association between quality of life measurements (i.e., the VAS and the EQ-5D-5L index) with each chronic disease and other sociodemographic variables. This model was also used to calculate the impact of combinations of diseases (i.e., a patient with more than one diagnosed chronic disease) on each of the two quality of life measures independently.

For the VAS, the models estimated were

$VAS_i = \alpha_0 + CD\_FREE_i\ \beta_0 + HBP_i\ \beta_1 + AMI_i\ \beta_2 + \ldots + PIDCA_i\ \beta_{30} + u_i$ (Model specification 1)

$VAS_i = \alpha_0 + CD\_FREE_i\ \beta_0 + HBP_i\ \beta_1 + AMI_i\ \beta_2 + \ldots + PIDCA_i\ \beta_{30} + WOMEN\ \delta_1 + age[25\text{-}34]\ \delta_2 + \ldots + age[>84]\ \delta_8 + INCOM\_PS\ \delta_9 + \ldots + UNIVERSITY\ \delta_{14} + u_i$ (Model specification 2)

for i = 20,587.

The same specification (Models 3 and 4) was done using the EQ-5D-5L index as the dependent variable instead of the VAS.

The complete list of regressors included the following variables: HBP (high blood pressure), AMI (acute myocardial infarction), OCD (other cardiovascular diseases), VV (varicose veins), OAR (osteoarthritis, arthritis or rheumatism), CBPu (chronic back pain upper), CBPl (chronic back pain lower), CA (chronic allergy), AS (asthma), COPD (chronic obstructive pulmonary disease), DIA (diabetes), SDU (stomach or duodenum ulcer), UI (urinary incontinence), HC (high cholesterol), CAT (cataract), CPS (chronic problems of the skin), CONS (constipation), CLD (cirrhosis, liver dysfunction), DEP (chronic depression) ANX (chronic anxiety), OMEN (other mental disorders), ESBH (embolism, stroke, cerebral hemorrhage), MFH (migraine or frequent headache), HEM (hemorrhoids), MT (malignant tumors), OST (osteoporosis), THYR (thyroid problems), PROS (prostate problems), MENO (menopausal problems), PIDCA (permanent injury or defect caused by accident), and the 30 chronic diseases diagnosed by a physician considered by the ENSE. Additional covariates included age (reference group: 18-24 years old), gender (woman=1; otherwise=0), and level of education (reference group: illiterate, incomplete primary school, completed primary school, secondary education, medium level of education, and university or similar).

Note that in specification (1) and (3), the constant term (α_0) is not interpretable. Rather, it is used to compute the differences in health outcomes between individuals with chronic disease and those who are free of disease ($\alpha_0 + \beta_0$). For example, to calculate the difference in the VAS between individuals free of chronic disease and those with high blood pressure, we would use the following expression: $(\alpha_0 + \beta_0) - (\alpha_0 + \beta_1)$. This would reduce to $(\beta_0 - \beta_1)$. The change in one of the values of the dummy variables is interpreted as the decrease in health caused by the chronic disease. Thus, β_1 (the coefficient for high blood pressure) represents a decrease from being diagnosed with the condition, controlling for the effect of the rest of variables included in the model.

A weighted least squares model was used with population weights, ensuring estimates that are representative of the Spanish population. The weighting factor applied for the estimation of the regression models was provided by the National Spanish Institute of Statistics (INE). This factor appropriately weighted the sample by age group (five-year age groups from 0-4 to 60-64 and 65 and over), gender (men / women), geographical area (regions), and nationality (Spanish or foreigner)[1].

Gretl 1.9.7 and STATA SE 12.0 software are used to perform the data analysis.

3.4 Output variables

Maximum stock of health: For a country, this was calculated as the maximum number of QALYs achievable by the population in one year, which is equivalent to having all individuals in full health in one year and therefore provided the best data on the hypothetical health status of a population.

[1] The INE methodology document can be consulted at: https://www.mscbs.gob.es/en/estadEstudios/estadisticas/encuestaNacional/encuestaNac2011/MetodologiaENSE2011_12.pdf.

Stock of health free from chronic disease: This measures the stock of health for individuals in the population who have not been diagnosed with a chronic illness. In the model, $(\alpha_0 + \beta_0)$ represents the quantity of stock of health per capita when an individual does not have a chronic illness. The stock of health free of illness for a country is therefore $(\alpha_0 + \beta_0)$ times the number of individuals in the population.

Stock of health loss related to chronic disease: This measures the impact of each illness on the stock of health free of chronic illness. In the model, each parameter (from β_1 to β_{30}) represents the stock of health loss per capita when an individual has a specific illness. The stock of health loss related to a given chronic disease, such as high blood pressure, was calculated as β_1 times the number of individuals with that specific illness.

Actual stock of health in 2011: For each country, this was measured as the stock of health for the population free from chronic illness minus the sum of the stock of health losses associated with each chronic disease. For individuals free of chronic diseases, the sum of the stock of health loss is zero.

4. Results

The final working sample was the adult population older than 18 years of age. Table I shows the sociodemographic characteristics of the population by gender, age, level of education, diagnosed chronic condition, and number of conditions diagnosed. The mean age for men was 46.95 years, compared to 49.11 among women. For the population without chronic conditions, the mean age was 37.1 years, while individuals with any of the diagnoses listed were on average older than 45 years. Women had a higher average number of conditions than men. The mean number of conditions increased with age, while

it decreased with education. The mean valuation of HRQoL was nearly 4 points higher for men (79.44 points in the VAS) than for women.

Table I also shows how individuals diagnosed with illnesses like osteoporosis or prostatic problems have a higher mean number of conditions than individuals with other illnesses. The cumulative percentage of individuals diagnosed with three conditions or more was approximately 40%. The mean age for these individuals was 37 for the population with no chronic illnesses and 65 for those with 5 or 6 chronic illnesses. Additionally, mean VAS and mean EQ-5D-5L index values were higher for those with no chronic conditions (87.26 VAS, 0.979 EQ-5D-5L index) compared to those with 5 or 6 chronic conditions (63.67 VAS, 0.814 EQ-5D-5L index).

Table I

Figure 1 shows the relationship that each disease had on HRQoL (e.g., VAS and EQ-5D-5L index) in the entire sample, regardless of the number of chronic conditions with which respondents were diagnosed. The additional association of being diagnosed with multiple conditions makes it impossible to establish a relationship between the disease and the cost of that disease in terms of its health impact. In fact, comorbidities impacted more than 50% of the sample. All diseases had values that were below the mean in comparison to those who did not have chronic illness. Figure 1 illustrates how other mental disorders and embolism, stroke, and cerebral hemorrhage are the conditions with the lowest mean values in the two HRQoL measures analyzed.

Figure 1

It is interesting to ascertain the relationship of each disease on HRQoL, accounting for respondents having other chronic disease(s). This was achieved by estimating a multivariable linear regression model. The model obtained mean values associated with each of the chronic diseases and showed how they affected each of the HRQoL measures. The results are shown in Table II.

The intercept plus the coefficient associated with CD_FREE in model specification (1) and (3) represents the mean value for the HRQoL measure (VAS or EQ-5D-5L index) for individuals who did not have any of the 30 chronic diseases listed in the survey (N = 5564). The estimated values for each of the HRQoL measures were 87.26 and 0.979 for the VAS and EQ-5D-5L index, respectively, which was the same mean value shown in Table I. These values are the reference values used to calculate the mean values for each of the diseases in the Spanish population. For example, according to the model estimates, people suffering from a myocardial infarction have a mean value of 80.34 points in the VAS (80.34 = 87.26 - 6.92), while those diagnosed with high blood pressure in addition to a myocardial infarction would have a mean value of 77.13 (77.13 = 87.26 - 6.92 - 3.21). The model allows separation of the influence of each chronic disease as well as aggregation of health losses due to the combination of more than one chronic disease being diagnosed. The maximum number of chronic diseases for an individual was 20 (i.e., no respondents reported more than 20 out of the 30 listed).

Using the model, we calculated and assigned an average impact value for each disease using HRQoL measures. However, for the mean value of the coefficients in the HRQoL measures for each disease, the model allowed calculations and assignments of the isolated

impact of each chronic disease controlling for the effect of any other disease introduced as covariates in the model.

Table II

Figure 2 shows the ranking of chronic diseases by their impact on HRQoL (from worst to best). Note that "worst" and "best" are subjective terms since diagnostics were self-reported by individuals. To obtain the ranking, we used model specifications (1) and (3). It seemed logical that not all chronic diseases had the same impact on respondents' quality of life. Therefore, this arrangement was considered when analyses were performed on the number of chronic diseases declared.

We observed that the first two diseases in the ranking were other mental disorders (1.87% of the population) and embolism, stroke, and cerebral hemorrhage (1.55%) and also had the strongest impact on HRQoL. Additionally, the total impact of the first twelve diseases in the ranking on the VAS showed a reduction for each disease of at least 8.5 points. Each of the last six diseases in the ranking had a maximum impact of 5 points on the VAS.

Figure 2

Table III shows the total association of each chronic disease on the stock of health for the overall population. Column (2), "Spanish population", represents the expected number of individuals in the Spanish population with each of the chronic diseases listed in 2011.

These values were obtained by multiplying the number of individuals in the sample reporting each disease (column (1), ENSE sample) by the ponderation to generate representative estimates for each of the disease groups in the Spanish population. Column (4), "Stock of health variation with respect to being free of disease", represents the stock of health lost in the population because of each disease. The variation in the stock of health was calculated for each chronic disease by multiplying the coefficient estimates of the regression by the number of individuals with that disease (column (3)). As a result, the numbers in column (4) represent how much stock of health the Spanish population lost due to each chronic disease. Finally, Column (5) shows the percentage of variation in the stock of health with respect to the stock of health in the population free of chronic diseases. This was calculated using the information in column (4), with 100% assigned to the population free of chronic diseases.

The maximum stock of health for any population would be equal to the total number of individuals in that population (Spain in the 2011-2012 year (P) = 40,852,036). To determine this number, it is necessary to assume that the maximum value for a state of perfect health for an individual in a year is 1.

Table III and Figure 2 show that diseases like cardiovascular diseases and other embolism, stroke, and cerebral hemorrhage have a very high impact (at the patient level) on HRQoL but a much lower impact on HRQoL at the population level due to the lower prevalence of these diagnoses. High blood pressure has a larger population-level impact since one out of four individuals were diagnosed with it. At the bottom of the ranking, we observed that the ranking of illnesses was similar for both HRQoL measures. The low position of conditions such as menopausal and prostate problems were not surprising given their low incidence and the specificity of these diseases. Similar results were also

found for cirrhosis and liver dysfunction, which was low in ranking when we considered the impact at the population level.

Table III

Given that the Spanish National Health Service already underestimates the relationship of chronic diseases on HRQoL, the loss in the stock of health in a year due to a specific illness is underestimated by the regression model. Figure 3 illustrates how the estimated VAS and EQ-5D-5L index values are lower than the population VAS and EQ-5D-5L index mean values. Individuals who report having no chronic illness have the same estimated values and observed values and therefore have a difference of zero. The opposite is shown for individuals with one or more chronic illnesses. The figure below shows the difference between population estimated values and sample mean values for the EQ-5D-5L index and VAS for each chronic disease. The estimated value is the impact on the stock of health controlling for the effect of other chronic diseases. The actual value is the mean among individuals who have only that specific disease. The difference between the actual and estimated values represent the consequence of comorbidities. Some significant differences between illnesses can be observed. For example, urinary incontinence (UI) has the highest difference, and chronic allergy (CA) has the lowest. The difference between estimated and mean values for those two are the highest (a difference of 16 points in the VAS and 0.14 in the EQ-5D-5L index).

Figure 3

In aggregate terms, chronic diseases represent 8.98 million units in the VAS of the stock of health losses for a country compared to a country free of those diseases. In Spain, the actual stock of health was 31.86 million units in the VAS for 2011. This implies a decrease of 32% in maximum attainable health and of almost 19% in the number obtained for a society free from chronic diseases.

Output variables: Health stock in VAS units (Spain, year 2011)

Maximum stock of health: 46,819,160 (100%)

Stock of health free from chronic disease: 40,852,036 (87.26%)

Stock of health loss of chronic disease (for all): 8,985,435 (19.19%)

Actual stock of health in 2011: 31,866,602 (68.07%)

5. Discussion

We analyzed data from the ENSE 2011-2012 survey to establish a ranking of chronic diseases in terms of HRQoL in the Spanish population. In this survey, three questions regarding chronic diseases appeared, and we analyzed responses to the question assessing whether participants were diagnosed with a chronic disease. This question was the most restrictive and was also the most reliable, particularly in comparison to the other two questions which asked respondents to report whether they ever experienced a chronic disease or whether they experienced one in the past 12 months.

The ranking we developed improves current evaluation methods for the impact of chronic diseases because it establishes an ordering of chronic illnesses by their impact on HRQoL. In doing so, we avoided summing the impact of each chronic illness, which incorrectly assumes they all have the same weight. Suffering from more diseases does not necessarily imply having a worse health status. Rather, health status depends on the weight the diseases have on the stock of health.

Both HRQoL measures, VAS and EQ-5D-5L index, yielded similar results in terms of the health impacts and ranking of diseases. There is a difference, however, on what each if these tools reflect. This difference is that VAS measures but does not assess preferences-based information. The EQ-5D-5L index, derived from the combination of the health profile description and a social tariff, assesses preference-based information. For broader objectives such as measuring or describing the health of a population, considering the VAS is still recommended as a relevant source of information.

Examining health losses for a society by allocating a weight to each of the chronic diseases actually measures the individuals' willingness to pay in points of HRQoL to not suffer from that specific illness.

There are other HRQoL measures that are extracted from the EQ-5D-5L, including the sum score (Hinz *et al*., 2014). The sum score is obtained by adding the corresponding levels of the 5 dimensions for each health profile. In this study, the EQ-5D-5L index was used instead of the sum score because prior studies have found that it yields results that are almost exactly the same, and perhaps more accurate (Hinz *et al.*, 2014). Additionally, country-specific weights for the EQ-5D-5L have already been developed for Spain (Ramos-Goñi *et al.*, 2017).

In this paper, we considered cost in terms of health to be of greater interest than the monetary cost of illnesses. Prices may vary depending on innovation or increases in productivity. However, variations in terms of the stock of health are maintained. While estimates of the prices are highly useful at the patient level because they approximate the costs faced by individuals due to their illness, considering that value in terms of population health can help set innovative research policies and better assist with illness prevention and intervention efforts.

In table II we estimated an additional model with gender, age groups, and education as controls. However, to obtain the stock of health of the population, we will still be using the model only with dummies for chronic diseases as regressors. Introducing controls would change the interpretation of the coefficients. For example, if we include age[>81] in the model, and we take the coefficient for High Blood Pressure (HBP), this will give the following interpretation of the coefficient: "the impact on the stock of health of having HBP, controlling for the impact on the stock of health of any other chronic disease, but also controlling for the impact on the stock of health of being over 81 years old". In this paper, though, we present the effect on the stock of health due to each of the chronic diseases, after having controlled for all other chronic diseases.

The consequence of comorbidity was assessed using a multiple regression model. The model provided estimates of stock of health losses due to any possible illness and combination of illnesses for individuals reporting more than one disease. Therefore, it allowed for comparisons of the difference between the stock of health losses related to having each of the combinations of illnesses. However, we did not examine the ranking of comorbidities, which would show the most frequent combination of diseases observed among the population analyzed. Rather, we were mainly interested in providing a ranking

of diseases by their importance. Further research could focus on analyzing diseases by their incidence in the sample.

There are some limitations in this study. First, the ENSE survey was not specifically designed for this study. The principal aim of the ENSE was to collect information about the health status of the Spanish population, health determinants, and health utilization and access to services. Second, the list of chronic diseases in the survey came from a closed list determined by the Spanish Ministry of Health. All conditions had the common characteristic of having a duration of more than 6 months and therefore could be considered chronic illnesses. However, the survey did not provide a full list of chronic diseases.

Further research should focus on collecting similar information in other countries to allow for cross-cultural comparisons.

6. Conclusion

Chronic diseases in Spain represent 19.19% of the stock of health losses compared to a country free of those diseases. In Spain, the stock of health in 2011 was 31.86 million units in the VAS, which is less than 46.81 million (the maximum attainable for the country) and 40.85 million (the amount needed for the country to be free from chronic diseases).

At the individual level, the diseases that have a stronger impact on loss of stock of health in Spain were mental illness and embolism, stroke, or cerebral hemorrhage. At the population level, the conditions with the largest impact were osteoarthritis, arthritis, or rheumatism, chronic back pain, and high blood pressure.

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Table I. Sociodemographic and clinical characteristics and HRQoL mean values for the ENSE population

	Group	Sample	% of Total	Mean Age	Mean Nº of Conditions	Mean VAS	Mean EQ INDEX	Mean VAS	Mean EQ INDEX	Mean VAS	Mean EQ INDEX
	Gender					TOTAL		Men		Woman	
	Men	10013	48.64	46.95	1.83	79.44	0,938	79.44	0,938		
	Women	10574	51.36	49.11	2.80	75.73	0,892			75.73	0,892
	Age										
	[18-24]	1820	8.84	21.01	0.62	88.16	0,976	89.33	0,980	86.99	0,972
	[25-34]	3740	18.17	29.85	0.88	85.37	0,970	86.21	0,974	84.49	0,966
	[35-44]	4244	20.62	39.50	1.37	81.41	0,950	82.10	0,957	80.68	0,942
	[45-54]	3663	17.79	49.36	2.18	77.17	0,928	78.24	0,943	76.12	0,913
	[55-64]	2812	13.66	59.33	3.32	73.16	0,899	74.97	0,926	71.46	0,873
	[65-74]	2162	10.5	69.19	4.23	69.82	0,865	72.67	0,910	67.29	0,826
	[75-84]	1609	7.82	79.06	5.16	62.57	0,781	65.39	0,831	60.63	0,747
	[85+]	535	2.6	88.63	5.33	54.55	0,625	58.29	0,698	52.55	0,586
	Level of Education										
	Illiterate	406	1.97	69.60	5.09	58.39	0,712	64.20	0,804	55.59	0,667
	Incomplete Primary School	2025	9.84	68.43	4.41	64.92	0,803	69.09	0,861	61.80	0,760
	Complete Primary School	2242	10.89	57.98	3.48	70.89	0,872	74.20	0,909	67.83	0,838
	Secondary Education	6620	32.16	46.30	2.27	78.02	0,920	79.93	0,941	76.03	0,898
	Medium Level of Education	5932	28.81	40.93	1.57	81.81	0,950	82.65	0,959	80.96	0,941
	University or Similar	3359	16.32	42.62	1.41	82.81	0,961	82.49	0,964	83.10	0,958
Acronym	**Illness**										
CD_FREE	Free of Illness	5564	27.03	37.16	0	87.26	0,980	87.57	0,981	86.87	0,978
HBP	High Blood Pressure	5388	26.17	63.47	4.98	66.89	0,832	81.33	0,968	81.27	0,968
AMI	Acute Myocardial Infarction	472	2.29	68.65	6.45	57.36	0,770	78.08	0,946	53.53	0,979
OCD	Other Cardiovascular Diseases	1541	7.49	67.26	6.54	59.32	0,754	79.22	0,951	73.81	0,936
VV	Varicose Veins	2994	14.54	60.06	5.68	67.09	0,819	80.68	0,979	84.29	0,967
OAR	Osteoarthritis, Arthritis or Rheumatism	5019	24.38	66.08	6.04	61.53	0,770	74.98	0,925	74.18	0,898
CBPu	Chronic Back Pain, Upper	3867	18.78	56.45	5.91	65.04	0,798	78.80	0,955	78.95	0,937
CBPl	Chronic Back Pain, Lower	4558	22.14	56.28	5.51	65.60	0,809	78.99	0,937	78.12	0,919
CA	Chronic Allergy	2526	12.27	45.71	4.15	74.56	0,898	83.31	0,974	82.91	0,964
AS	Asthma	1101	5.35	47.07	4.95	70.96	0,868	84.08	0,976	83.85	0,972
COPD	Chronic Obstructive Pulmonary Disease	1115	5.42	62.07	6.64	60.92	0,781	72.84	0,930	73.27	0,936
DIA	Diabetes	1857	9.02	65.55	5.86	62.02	0,789	77.18	0,958	72.36	0,904
SDU	Stomach or Duodenum Ulcer	1020	4.95	59.35	5.94	64.45	0,825	75.71	0,957	77.56	0,922
UI	Urinary Incontinence	962	4.67	72.51	8.04	53.57	0,643	75.88	0,876	76.01	0,816
HC	High Cholesterol	4543	22.07	59.71	4.99	68.63	0,852	77.44	0,951	75.61	0,918
CAT	Cataract	2326	11.30	73.39	6.37	61.79	0,762	75.11	0,917	69.35	0,830
CPS	Chronic Problems of the Skin	1045	5.08	52.49	5.67	67.03	0,825	76.30	0,946	78.42	0,940
CONS	Constipation	1030	5.00	61.32	7.43	59.91	0,730	72.00	0,913	70.03	0,866
CLD	Cirrhosis, Liver Dysfunction	241	1.17	58.46	6.33	60.23	0,770	70.62	0,936	63.01	0,853
DEP	Chronic Depression	1921	9.33	58.43	7.12	57.22	0,695	65.04	0,769	65.59	0,805
ANX	Chronic Anxiety	1826	8.87	54.26	6.66	59.36	0,723	67.19	0,857	65.61	0,795
OMEN	Other Mental Disorders	385	1.87	63.30	5.77	50.08	0,595	64.02	0,774	49.03	0,583
ESBH	Embolism, Stroke, Cerebral Hemorrhage	321	1.56	69.02	6.94	51.38	0,635	63.70	0,781	50.03	0,596
MFH	Migraine or Frequent Headache	2132	10.36	49.81	5.39	66.98	0,827	74.63	0,914	72.60	0,877
HEM	Hemorrhoids	1483	7.20	58.45	6.39	65.17	0,815	74.04	0,911	67.98	0,842
MT	Malignant Tumors	738	3.58	64.45	5.92	60.88	0,790	63.07	0,832	63.29	0,803
OSTH	Osteoporosis	1159	5.63	68.75	7.56	58.80	0,718	59.64	0,733	60.18	0,742
THYR	Thyroid Problems	1234	5.99	54.96	5.21	69.84	0,844	74.31	0,924	71.27	0,854
PROS	Prostate Problems	832	4.04	72.74	5.73	64.87	0,828	65.55	0,837	.	.
MENO	Menopausal Problems	646	3.14	55.49	6.28	65.44	0,809	.	.	66.62	0,819
PIDCA	Permanent Injury or Defect by Accident	1224	5.95	51.14	4.88	68.63	0,825	70.91	0,860	65.31	0,768
	Number of Illnesses (Dx)										
	0	5564	27.03	37.16	0	87.26	0,980	87.57	0,981	86.87	0,978
	1-2	6837	33.21	46.29	1.39	80.46	0,951	80.48	0,955	80.45	0,947
	3-4	3697	17.96	55.66	3.43	72.40	0,902	72.69	0,918	72.17	0,889
	5-6	2123	10.31	61.96	5.43	63.67	0,814	62.86	0,838	64.17	0,800
	7-8	1230	5.97	65.45	7.42	56.88	0,726	56.94	0,744	56.87	0,719
	9-10	616	2.99	68.00	9.40	52.75	0,654	51.05	0,684	53.41	0,642
	11-15	471	2.29	69.58	12.36	46.02	0,536	42.75	0,564	46.90	0,528
	16-20	49	0.25	69.00	16.84	35.77	0,387	45.56	0,354	33.49	0,395
	Total	**20587**	**100**	**48.06**	**2.32**	**77.53**	**0,914**	79.44	0,938	75.73	0,892

Note: Weighting factor applied (includes gender, age and geographical area) to ensure sample representativeness of the Spanish population.

Table II. Model results (WLS) for VAS and EQ-5D-5L index

	VAS				EQ INDEX			
	(1)		(2)		(3)		(4)	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
intercept	83.307	0.220 **	81.432	0.923 **	0.9867	0.0017 **	0.9227	0.0068 **
CD_FREE	3.954	0.286 **	2.583	0.289 **	−0.0067	0.0022 **	-0.0133	0.0022 **
HBP	-3.216	0.291**	-1.996	0.294 **	−0.0239	0.0022 **	-0.0163	0.0022 **
AMI	-6.925	0.766 **	-6.150	0.755 **	−0.0274	0.0059 **	-0.0195	0.0058 **
OCD	-5.349	0.474 **	-4.408	0.469 **	−0.0470	0.0037 **	-0.0354	0.0036 **
VV	-0.401	0.352	0.210	0.349	−0.0072	0.0027 **	-0.0040	0.0027
OAR	-7.521	0.331 **	-5.528	0.340 **	−0.0721	0.0026 **	-0.0557	0.0026 **
CBPu	-1.859	0.348 **	-2.068	0.342 **	−0.0265	0.0027 **	-0.0283	0.0026 **
CBPl	-3.475	0.324 **	-3.509	0.319 **	−0.0328	0.0025 **	-0.0352	0.0024 **
CA	0.987	0.345 **	-0.198	0.342	0.0074	0.0027 **	0.0002	0.0026
AS	-0.844	0.510 *	-1.356	0.503 **	−0.0041	0.0040	-0.0039	0.0039
COPD	-4.728	0.530 **	-4.053	0.522 **	−0.0280	0.0041 **	-0.0226	0.0040 **
DIA	-5.187	0.427 **	-4.433	0.422 **	−0.0386	0.0033 **	-0.0350	0.0032 **
SDU	-2.318	0.531 **	-2.337	0.523 **	0.0063	0.0041	0.0022	0.0040
UI	-5.187	0.619 **	-3.276	0.618 **	−0.1040	0.0048 **	-0.0738	0.0047 **
HC	-0.711	0.295 **	-0.487	0.292 *	0.0057	0.0023 *	0.0018	0.0022
CAT	-2.550	0.419 **	0.042	0.436	−0.0378	0.0032 **	-0.0057	0.0033 *
CPS	-1.795	0.502 **	-2.503	0.494 **	−0.0154	0.0039 **	-0.0203	0.0038 **
CONS	-2.352	0.561 **	-1.961	0.552 **	−0.0428	0.0044 **	-0.0354	0.0042 **
CLD	-5.954	1.046 **	-5.704	1.028 **	−0.0427	0.0080 **	-0.0444	0.0078 **
DEP	-5.761	0.505 **	-5.506	0.498 **	−0.0839	0.0039 **	-0.0854	0.0038 **
ANX	-5.260	0.489 **	-5.679	0.482 **	−0.0676	0.0038 **	-0.0724	0.0037 **
OMEN	-15.615	0.872 **	-13.536	0.863 **	−0.1972	0.0065 **	-0.1687	0.0064 **
ESBH	-11.047	0.958 **	-10.118	0.942 **	−0.1457	0.0074 **	-0.1343	0.0072 **
MFH	-2.482	0.373 **	-3.017	0.370 **	−0.0140	0.0029 **	-0.0168	0.0028 **
HEM	-0.681	0.462	-0.862	0.455 *	0.0098	0.0036 **	0.0038	0.0035
MT	-7.186	0.635 **	-6.731	0.625 **	−0.0435	0.0049 **	-0.0400	0.0047 **
OSTH	-2.494	0.560 **	-1.681	0.554 **	−0.0435	0.0043 **	-0.0378	0.0042 **
THYR	0.130	0.474	0.033	0.471	−0.0051	0.0037	-0.0084	0.0036 **
PROS	-0.658	0.611	0.394	0.622	0.0155	0.0047 **	0.0213	0.0047 **
MENO	-1.754	0.656 **	-1.525	0.654 **	−0.0116	0.0051 *	-0.0168	0.0050 **
PIDCA	-2.458	0.465 **	-2.937	0.459 **	−0.0415	0.0036 **	-0.0464	0.0035 **
WOMAN			-0.469	0.228 **			-0.0073	0.0017 **
Age [25-34]			-2.079	0.423 **			-0.0008	0.0032
Age [35-44]			-4.289	0.419 **			-0.0088	0.0032 **
Age [45-54]			-5.695	0.439 **			-0.0083	0.0034 **
Age [55-64]			-5.560	0.481 **			-0.0040	0.0037
Age [65-74]			-5.613	0.539 **			-0.0086	0.0041 **
Age [75-84]			-8.867	0.620 **			-0.0532	0.0047 **
Age [>84]			-14.980	0.845 **			-0.1801	0.0064 **
Incom_PS			3.389	0.848 **			0.0598	0.0062 **
Complete_PS			4.485	0.849 **			0.0766	0.0062 **
Secondary			6.399	0.826 **			0.0763	0.0060 **
Medium			7.142	0.837 **			0.0806	0.0061 **
University			7.902	0.854 **			0.0871	0.0063 **
N obs		20421		20421		20587		20587
F-Statistic		369.02 **		287.01 **		552.49 **		449.20 **
R-squared		0.3594		0.3826		0.4545		0.490
Adj R-squar.		0.3584		0.3813		0.4537		0.489

Where CD_FREE (chronic disease free), HBP (high blood pressure), AMI (acute myocardial infarction), OCD (other cardiovascular diseases), VV (varicose veins), OAR (osteoarthritis, arthritis or rheumatism), CBPu (chronic back pain, upper), CBPl (chronic back pain lower), CA (chronic allergy), AS (asthma), COPD (chronic obstructive pulmonary disease), DIA (diabetes), SDU (stomach or duodenum ulcer), UI (urinary incontinence), HC (high cholesterol), CAT (cataract), CPS (chronic problems of the skin), CONS (constipation), CLD (cirrhosis, liver dysfunction), DEP (chronic depression) ANX (chronic anxiety), OMEN (other mental disorders), ESBH (embolism, stroke, cerebral hemorrhage), MFH (migraine or frequent headache), HEM (hemorrhoids), MT (malignant tumors), OST (osteoporosis), THYR (thyroid problems), PROS (prostate problems), MENO (menopausal problems), PIDCA (permanent injury or defect caused by accident). Additional covariables are Age (reference group [18-24]), WOMAN (woman =1, 0 otherwise) Level of education. (reference group (Illiterate); Incomplete_PS: incomplete primary school; Complete_PS: complete primary school; Secondary: secondary education; Medium: medium level of education; University: university or similar).

*** $p < 0.10$, ** $p < 0.05$**

Table III. Health stock for chronic diseases in Spain (2011)

Disease		ENSE Population (N=20587)	Spanish Population (P=46815916)	Variation with Respect to Free of Disease	Variation Health Stock Free of Disease (HSF=40852036)	Variation of Health Stock (%)
		(1)	(2) = P*((1)/N)	(3)	(4) = ((3)/100)*(2)	(5)=(4)/HSF %
Free of Disease		5564	12652827	-	-	-
Osteoarthritis, Arthritis or Rheumatism	OAR	5019	11413469	-11.475	-1309696	-3.21%
High Blood Pressure	HBP	5388	12252594	-7.170	-878511	-2.15%
Chronic Back Pain Lower	CBPl	4558	10365131	-7.429	-770026	-1.88%
Chronic Back Pain Upper	CBPu	3867	8793760	-5.813	-511181	-1.25%
High Cholesterol	HC	4543	10331020	-4.665	-481942	-1.18%
Chronic Depression	DEP	1921	4368455	-9.715	-424395	-1.04%
Diabetes	DIA	1857	4222915	-9.141	-386017	-0.94%
Chronic Anxiety	ANX	1826	4152420	-9.214	-382604	-0.94%
Cataract	CAT	2326	5289446	-6.504	-344026	-0.84%
Other Cardiovascular Diseases	OCD	1541	3504315	-9.303	-326006	-0.80%
Migraine or Frequent Headache	MFH	2132	4848280	-6.436	-312035	-0.76%
Varicose Veins	VV	2994	6808513	-4.355	-296511	-0.73%
Chronic Bronchitis, Emphysema, COPD	COPD	1115	2535568	-8.682	-220138	-0.54%
Urinary Incontinence	UI	962	2187638	-9.141	-199972	-0.49%
Malignant Tumors	MT	738	1678251	-11.140	-186957	-0.46%
Permanent Injury or Defect Caused by Accident	PIDCA	1224	2783440	-6.412	-178474	-0.44%
Other Mental Disorders	OMEN	385	875510	-19.569	-171329	-0.42%
Chronic Allergy	CA	2526	5744256	-2.967	-170432	-0.42%
Osteoporosis	OSTH	1159	2635627	-6.448	-169945	-0.42%
Hemorrhoids	HEM	1483	3372420	-4.635	-156312	-0.38%
Constipation	CONS	1030	2342274	-6.306	-147704	-0.36%
Stomach or Duodenum Ulcer	SDU	1020	2319533	-6.272	-145481	-0.36%
Chronic Problems of the Skin	CPS	1045	2376385	-5.749	-136618	-0.33%
Asthma	AS	1101	2503732	-4.798	-120129	-0.29%
Acute Myocardial Infarction	AMI	472	1073353	-10.879	-116770	-0.29%
Embolism, Stroke, Cerebral Hemorrhage	ESBH	321	729971	-15.001	-109503	-0.27%
Thyroid Problems	THYR	1234	2806181	-3.824	-107308	-0.26%
Prostate Problems	PROS	832	1892012	-4.612	-87260	-0.21%
Menopausal Problems	MENO	646	1469038	-5.708	-83853	-0.21%
Cirrhosis, Liver Dysfunction	CLD	241	548047	-9.908	-54300	-0.13%

Figure 1. Impact of chronic disease on VAS and EQ-5D-5L index

The boxes represent values between the 25th percentile (bottom) and 75th percentile (top). The horizontal line inside the boxes represents the median value in the sample. Values outside of the 95% confidence intervals are not included.

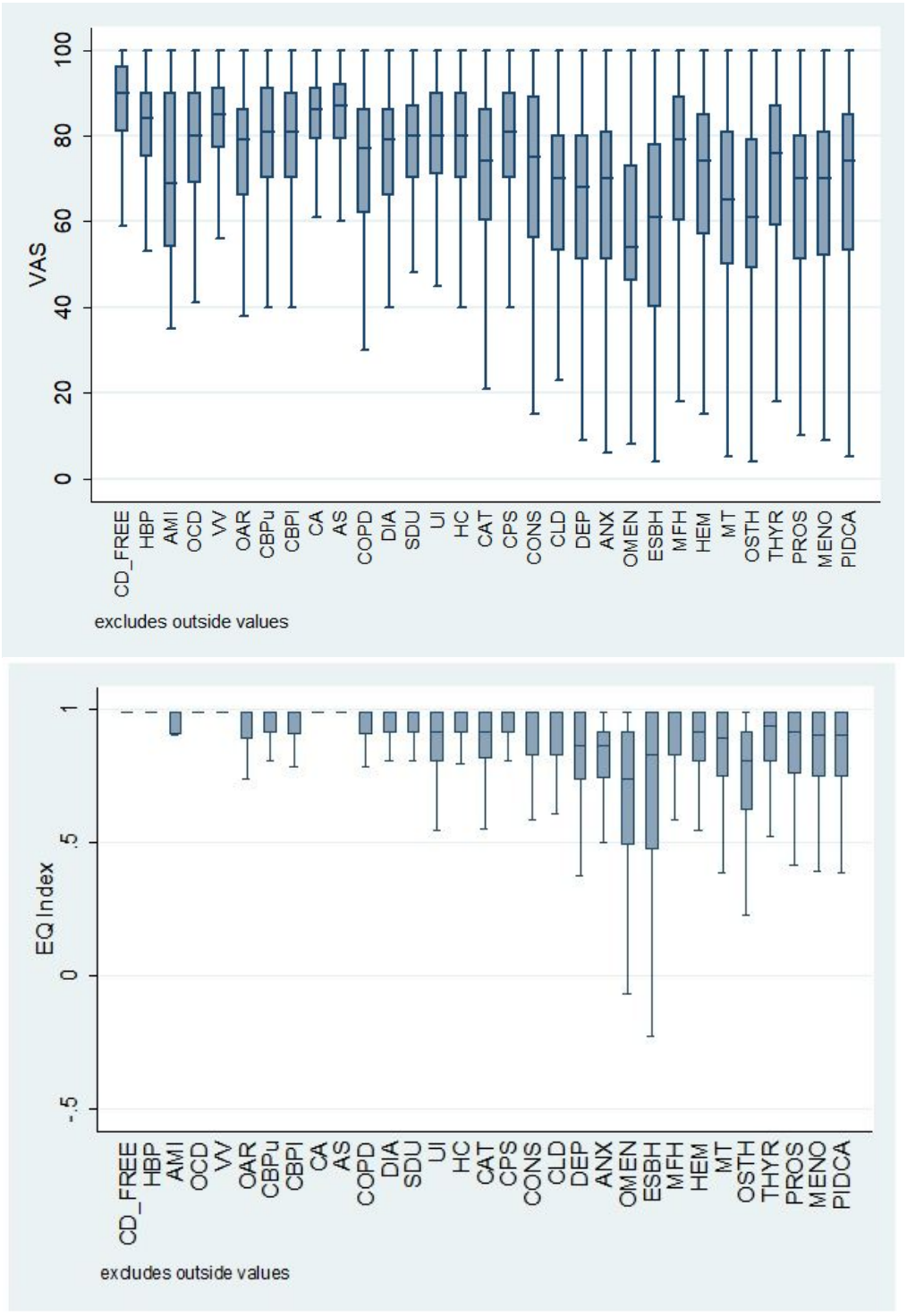
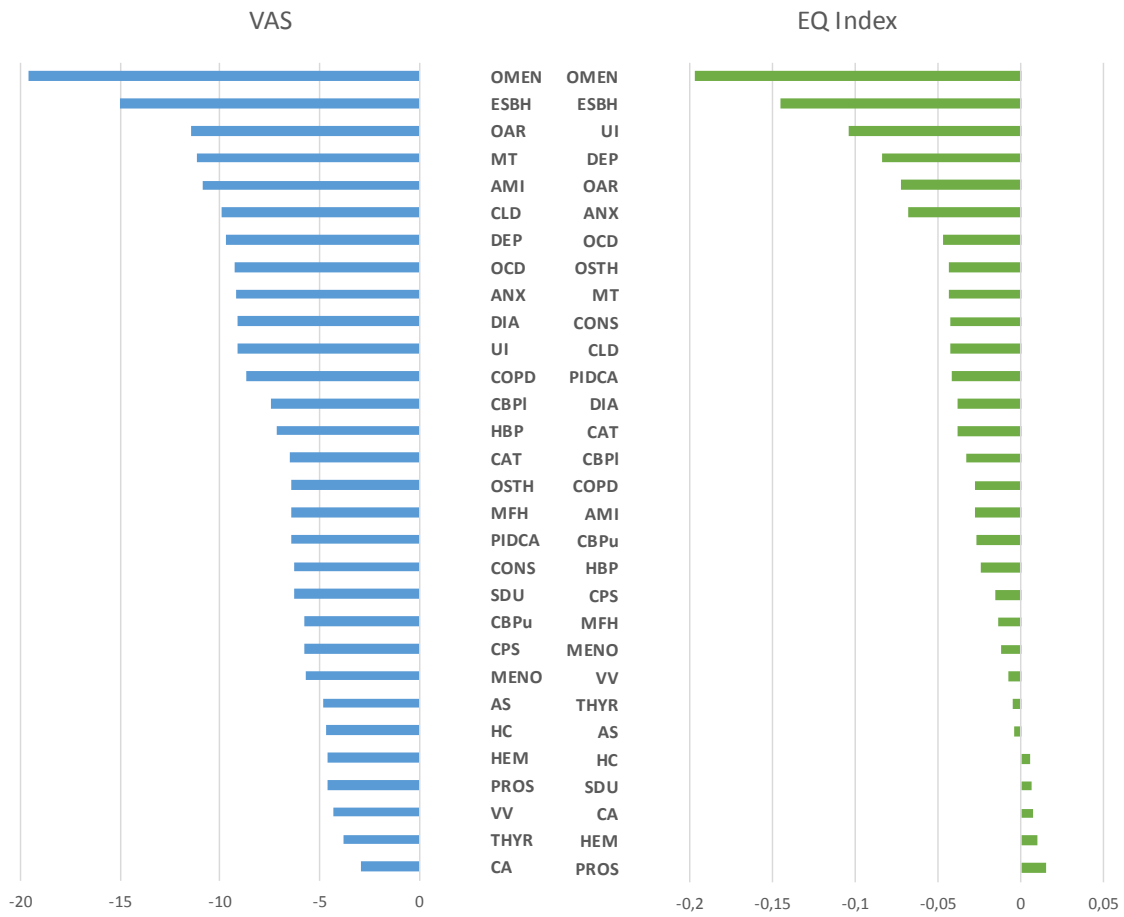
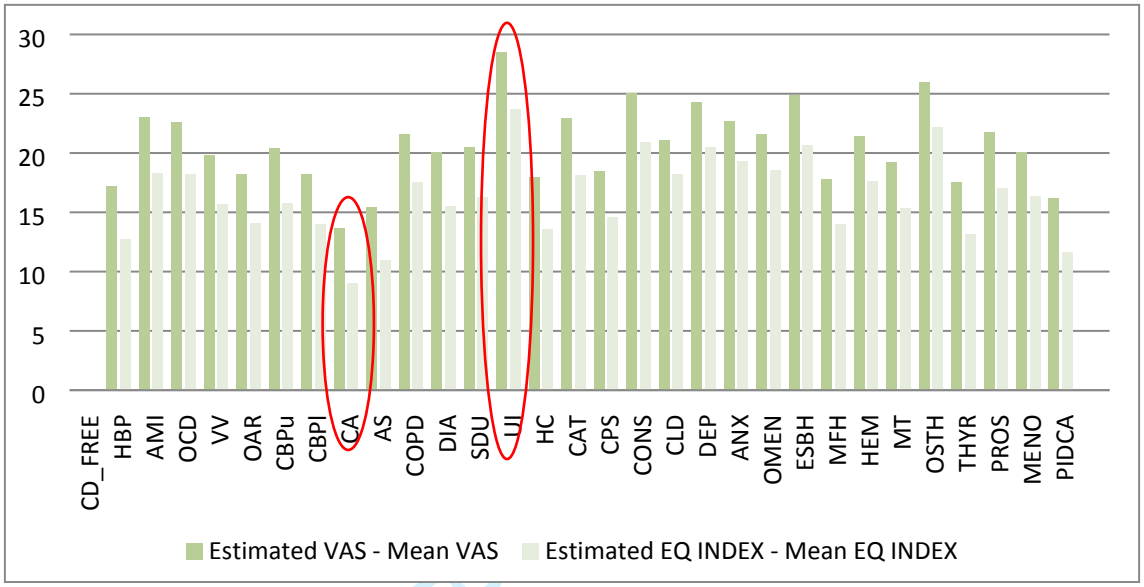


Figure 2. Ranking of chronic diseases by their impact on HRQoL measures (VAS and EQ-5D-5L index)



Where HBP (high blood pressure), AMI (acute myocardial infarction), OCD (other cardiovascular diseases), VV (varicose veins), OAR (osteoarthritis, arthritis or rheumatism), CBPu (chronic back pain, upper), CBPl (chronic back pain, lower), CA (chronic allergy), AS (asthma), COPD (chronic obstructive pulmonary disease), DIA (diabetes), SDU (stomach or duodenum ulcer), UI (urinary incontinence), HC (high cholesterol), CAT (cataract), CPS (chronic problems of the skin), CONS (constipation), CLD (cirrhosis, liver dysfunction), DEP (chronic depression) ANX (chronic anxiety), OMEN (other mental disorders), ESBH (embolism, stroke, cerebral hemorrhage), MFH (migraine or frequent headache), HEM (hemorrhoids), MT (malignant tumors), OST (osteoporosis), THYR (thyroid problems), PROS (prostate problems), MENO (menopausal problems), PIDCA (permanent injury or defect caused by accident).

Figure 3. Differences between the mean of observed values and estimated VAS and EQ-5D-5L index (times 100).



Conflicts of Interest

The authors declare there are no conflicts of interest.

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